



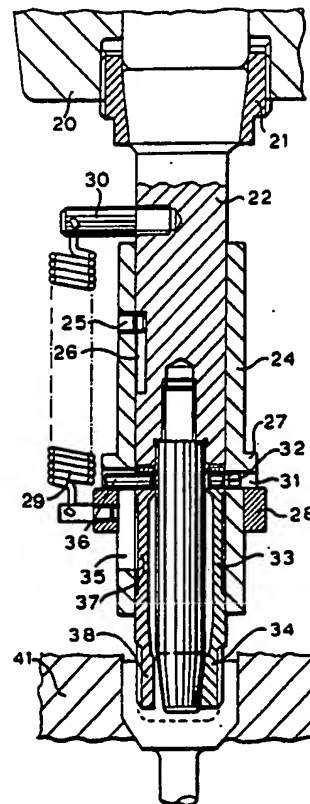
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁴ : B21K 1/76, B21D 53/84		A1	(11) International Publication Number: WO 85/ 03655
			(43) International Publication Date: 29 August 1985 (29.08.85)
(21) International Application Number: PCT/GB85/00036 (22) International Filing Date: 24 January 1985 (24.01.85) (31) Priority Application Number: 8404321 (32) Priority Date: 18 February 1984 (18.02.84) (33) Priority Country: GB (71) Applicant (for all designated States except US): PFD LIMITED [GB/GB]; 27 Roman Way, Coleshill, Birmingham B46 1HQ (GB). (72) Inventors; and (75) Inventors/Applicants (for US only) : LANGFORD, Edward, Alfred [GB/GB]; 37 Tudor Hill, Sutton Coldfield, Birmingham B73 6BE (GB). MORDEN, Geoffrey, Allen [GB/GB]; 37 Welford Road, Sutton Coldfield, Birmingham B96 6ED (GB).		(74) Agents: ROBERTSON, Bernard, C. et al.; Guest, Keen and Nettlefolds, plc., Group Patents & Licensing Department, P.O. Box 55, Ipsley House, Ipsley Church Lane, Redditch, Worcestershire B98 0TL (GB). (81) Designated States: AT (European patent), AU, BE (European patent), BR, CH (European patent), DE (European patent), FR (European patent), GB, GB (European patent), JP, KR, LU (European patent), NL (European patent), SE (European patent), SU, US. Published With international search report.	

(54) Title: TOOL FOR AND METHOD OF MAKING HOLLOW ARTICLES

(57) Abstract

A tool for use in the manufacture of the outer member of a cross-groove type of constant velocity ratio universal joint, by forming a blank in a die with the tool in the interior of the blank to define the internal shape of the joint member. The tool comprises first and second elements (33, 37) with portions (34, 38) which together define the shape required in the joint outer member, having formations (34a, 38a) which form the grooves therein, and have an internal cavity (40) which receives an expander (23) to hold the elements in their operative positions. After withdrawal of the expander, the first elements (33) can be moved radially inwardly to disengage them from the formed joint member and withdrawn, following which the second elements (34) can be moved inwardly and subsequently withdrawn.



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TOOL FOR AND METHOD OF
MAKING HOLLOW ARTICLES

This invention relates to the manufacture of hollow articles. The invention has been developed for the manufacture of the outer member of a constant velocity universal joint of the cross-groove type. In such a joint, there is
5 an inner member and an outer member, the outer member having an internal cylindrical surface and the inner member an external cylindrical surface which surfaces are grooved and there are two sets of, preferably, helical grooves in each member, the grooves of the two sets being on helices of
10 opposite hand. For manufacturing simplicity, the grooves may be straight and inclined to the rotational axis of the joint member, instead of being truly helical. Balls are engaged in the grooves and are held in a cage and because of the crossed configuration of the grooves the balls are held
15 in the bisector plane of the joint as the parts of the joint articulate, to give the joint constant velocity ratio (homokinetic) properties.

Although the invention has been developed for making outer members for such cross-groove constant velocity joints
20 it is applicable generally to the manufacture of hollow articles of the type, hereinafter referred to as being of the type specified, having at least two grooves in the internal surface thereof, the grooves having longitudinal axes of symmetry (as hereinafter defined) which differ (as
25 hereinafter defined). The article may have at least two sets of grooves with the grooves in each set being spaced round the longitudinal axis of the bore and having longitudinal axes of symmetry which are the same (as hereinafter defined), the longitudinal axes of symmetry of
30 the grooves in one set being different from the longitudinal axes of symmetry of the grooves in the other set.

By longitudinal axis of symmetry of a groove we mean the imaginary line which is equally spaced from the edges of the groove and which lies in an imaginary surface forming a continuation of the bore surface and containing said edges.

5 When we say that the longitudinal axes of symmetry are the same we mean that the loci of points moving in synchronism from the one ends of said axes to the other bear a fixed relation to one another. Conversely, when we say that the longitudinal axes of symmetry differ we mean that
10 the loci of such moving points do not lie in a fixed relation to one another. Thus, for example, the axes could be on helices of different hand, or of the same hand and different pitch or on helices of different pitch and hand. Some of the axes could be straight and others could be
15 helical.

Presently in the manufacture of outer members for cross-groove constant velocity joints the blanks are made by forging, extrusion or some other metal forming method and the grooves are then machined in the bore. Such machining
20 operations are expensive in time and equipment besides removing material. It would be convenient to be able to form the grooves in the bore without removal of metal or even to make them with imprecise grooves which would require less machining than at present. However since the
25 longitudinal axes of symmetry of the grooves differ as defined above a one-piece tool could not be removed from the bore after the grooves had been formed.

It is an object of one aspect of the invention to provide a tool for making hollow articles of the type
30 specified and particularly for making outer members of constant velocity joints in which machining of the grooves may be reduced or eliminated.

The present invention provides a tool for use in the manufacture of a hollow article of the type specified, comprising a plurality of elements having portions together adapted to define a substantially complete external surface
5 having a configuration corresponding to that required in the internal surface and having formations corresponding to that required in the internal surface and having formations corresponding to and adapted to form said grooves, said elements including first elements and second elements
10 interposed between them, and the arrangement being such that said portions of said first elements can be withdrawn from the article to leave a space or space to permit said second elements subsequently to be moved inwardly to disengage them from said internal surface and withdrawn from the article.

15 By a substantially complete surface, we mean one in which there are no gaps or discontinuities sufficient for the material of the article to enter during the forming process, and which material would have to be removed subsequently, e.g. by machining. By use of the tool
20 according to the invention, the requirement for finish machining of the article can be reduced or eliminated.

Preferably the elements of the tool together define an internal cavity into which an expander member is movable to hold the elements in their positions in which they define
25 the external surface, and from which the expander member can be withdrawn to permit the first elements of the tool to be moved inwardly into the cavity prior to their withdrawal, the side faces of at least said portions of the first elements, which contact at least said portions of the second
30 elements being parallel to one another or convergent towards the outside of the tool.

Inward movement of the first elements of the tool prior to their withdrawal enables the elements to have formations which form the helical or inclined grooves in the bore of
35 the article.

Preferably each of said portions of said first elements has a formation adapted to form one of said grooves of one set thereof, and each portion of a second element has a formation adapted to form one of said grooves of another set thereof which differs from said one set.

In their operative positions, the second elements may be supported by the side faces of the first elements, rather than directly by the expander member.

Further details of the tool according to the invention are described hereafter.

The invention also provides a press fitted with a tool into the invention, and further comprising a die through which a hollow blank having the tool inside it can be pressed to form the article. A particularly useful form of blank is also described hereafter.

The invention will now be described by way of example with reference to the accompanying drawings, of which;

Figure 1 is an end view of an outer member of a cross groove constant velocity ratio universal joint, constituting an article of the type specified.

Figure 2 is a section through the joint outer member of Figure 1.

Figure 3 is an end view of a blank to be used according to the invention in making the joint outer member.

Figure 4 is a section through the blank of Figure 3.

Figure 5 is a section through part of the press according to the invention, in a first stage of operation.

Figure 6 shows the press of Figure 5, in a second stage of operation.

Figure 7 shows the press of Figures 5 and 6, in a third stage of operation.

5 Figure 8 is an enlarged view of part of a tool according to the invention, in section on the line 8-8 of Figure 9.

Figure 9 is an end view of the tool.

Referring firstly to Figures 1 and 2, these show the
10 outer member of a cross groove constant velocity ratio universal joint, which is a hollow article with a cylindrical internal bore having a number of grooves therein. The central axis of the cylindrical bore, which is the rotational axis of the joint member in use, is indicated at 100.
15 The joint member contains two sets of three grooves each, the grooves being of arcuate cross sectional shape and having helical longitudinal axes of symmetry. One set of grooves is indicated at 57, 58, 59 and these grooves are inclined in an anticlockwise helical sense when considered
20 from above the joint member. The other set of grooves 60, 61, 62 are inclined in a clockwise helical sense when considered from above the joint member. The longitudinal axis of symmetry of each of the grooves is indicated by the number of the groove with the suffix letter a, such axis of
25 symmetry lying equidistant from the edges of the groove and on the imaginary cylinder indicated by line 101, the cylinder containing the bore of the joint member.

At present, in the manufacture of constant velocity joint outer members such as these, the grooves are machined
30 in a blank which has been forged or extruded. Because the

grooves are inclined in opposite hands, if they were formed by a one piece tool during extrusion of the article the tool would not be able to be removed from the finished article. The present invention provides a tool which is capable of
5 being removed from such a joint outer member.

Referring now to Figures 3 and 4 of the drawings, there is shown a configuration of blank which may with advantage be used with the tool to be described hereafter. It is cup shaped, with its internal and external walls diverging
10 towards its free open end. The internal wall 70 is of generally frusto conical form, with two sets of oppositely inclined recesses therein. One set of recesses is indicated at 71, 72, 73, inclined in one direction, and the other set at 74, 75, 76 inclined in the opposite direction. These
15 recesses, which are to form the grooves in the finished joint outer member, are of a configuration such that a one-piece forming tool can be withdrawn axially from the blank after the blank has been formed. Forming the blank to the finished joint outer member is achieved by inserting the
20 tool to be described hereafter into the blank and forcing the blank through a die so as to deform the side wall of the blank inwardly as indicated by arrows 80 in Figure 4.

Referring now to Figure 5 of the drawings, there is shown a ram 20 of a press to which is secured, by a screw-
25 threaded connection ring 21, a mandrel 22. The lower end of mandrel 22 has secured to it an elongate cylindrical expander member 23. A sleeve 24 is slidable longitudinally of mandrel 22, between limits determined by a peg 25
30 extending inwardly from sleeve 24 into a longitudinally extending slot 26 in mandrel 22. Towards the lower end of sleeve 24, there is a circumferentially extending flange 27, and slidable on sleeve 24 below the flange 27 is a collar 28. The collar 28 is spring biased upwardly by a plurality of tension springs 29 spaced around the collar, only one of
35 which springs is shown in the drawing. The springs 29 engage pins 30 extending into the mandrel 22.

Within flange 27, the sleeve 24 is provided with three equally circumferentially spaced radial apertures 31. Each aperture 31 receives a ball end of a peg 32 extending outwardly from the upper end of an element 33 having a head 34 at its lower end. Circumferentially spaced about sleeve 24, between the apertures 31, are three slots 35 which extend downwardly from flange 27. Each slot 35 receives a peg 36 extending outwardly from the upper end of an element 37 having a head 38 at its lower end. The pegs 36 are long enough to be engaged by collar 28. The head portions 34, of elements 33, together define parts of an internal cavity 40 which is frusto conical and in which an end portion of the expander member 23 is a close fit.

The shapes of the head portions 34, 38 of elements 33, 37 are shown in greater detail in Figures 8 and 9 of the drawings. Head portions 34 have formations 34_a thereon which form the grooves of one hand, and head portions 38 have formations 38_a which form the grooves of opposite hand in the joint member. It will be noted that head portions 34 have sides which are parallel or converge slightly towards the outside of the tool, while head portions 38 interposed there between are wedge shaped and are supported by the sides of head portions 34 rather than directly by contact with the end portion of the expander member.

In use of the apparatus, the assembly of elements 33, 37, with the expander member 23 therein, is introduced into a blank as shown in Figures 3 and 4. The press is then used to force the blank with the tool within it into a die 41. This has the effect of deforming inwardly the wall of the blank adjacent its free end, to conform to the surface shape of the assembled tool elements.

The tool must then be withdrawn from the formed joint outer member, and the first stage in such withdrawal is shown in Figure 6.

Initially, the open end of the joint outer member is engaged by suitable gripper means, not shown, to prevent its upward movement. Thereafter, mandrel 22 is raised by operation of the press. Since the elements 33, 37 cannot be withdrawn together from the joint outer member because of the grooves therein the sleeve 24 remains in a fixed position as the mandrel is raised, until peg 25 abuts the lower end of slot 26. During this, springs 29 have been tensioned, while the expander member, fast with mandrel 22, has been withdrawn clear of the internal cavity of the head portions of elements 33, 37.

The elements 33 are now free to tilt inwardly. This tilting is possible by virtue of the ball ends of pegs 32 engaging in apertures 31. Such tilting permits the head portions to be withdrawn from the joint outer member, with continued upward movement of mandrel 22. Head portions 38 of elements 37 remain in contact with the joint outer member, supported by elements 33.

On continued upward movement of mandrel 22, springs 29 are tensioned further as pegs 36 on elements 37 move down slots 35, taking collar 28 down the sleeve 24 with them. Ultimately a position as shown in Figure 7 is reached, in which pegs 36 have reached the lower ends of slots 35 tensioning springs 29 to their fullest extent. The elements 37 are now no longer supported by elements 33.

The condition shown in Figure 7 will not exist more than momentarily, since there will be a tendency for the elements 37 to move inwardly as soon as their support by elements 33 ceases. However, as a consequence of the deformation of the material of the joint outer member, the elements 37 and indeed, elements 33 at an earlier stage, may

adhere thereto so that an appreciable force needs to be exerted, by pegs 36 engaging bottoms of slots 35, before the elements 37 will remove from the joint outer member. This is why the joint outer member must be engaged by some form of gripper. As soon as the elements 37 are clear of the joint outer member, springs 29 will bring collar 28 upwardly and return, firstly, the elements 37 to their starting position. Thereafter springs 29 will bring sleeve 24 along with collar 28 upwardly to its original position relative to mandrel 22, and the parts will then regain their relative positions illustrated in Figure 5.

Although as described the apparatus is used for the manufacture of the outer member of a constant velocity ratio universal joint, it will be appreciated that it is suitable for manufacture of other components of the same general configuration, having an internal surface with grooves of different hand therein. There may be other numbers of elements such as elements 33, 37, according to the shape of the component to be manufactured.

Although as described above the tool assembly is mounted on the ram of the press and the die is fixed on the base of the press, it would be possible for the die rather than the tool assembly to be moved by the press ram. The relative movements occurring between the parts of the tool assembly and the die would be the same.

CLAIMS

1. A tool for use in manufacture of a hollow article of the type specified, said tool comprising a plurality of elements (33, 37) having portions (34, 38) together adapted to define a substantially complete external surface having a configuration corresponding to that required in said internal surface, and having formations (34a, 38a) corresponding to and adapted to form said grooves, said elements including first elements (33) and second elements (37) interposed between them, and the arrangement being such that said portions (34) of said first elements (33) can be withdrawn from said article to leave a space or spaces to permit said second elements (37) subsequently to be moved inwardly to disengage them from said internal surface and withdrawn from said article.

2. A tool according to Claim 1 further characterised in that said portions (34, 38) of said elements (33, 37) of the tool together define an internal cavity (40) into which an expander member (23) is movable to hold said elements (33, 37) in their positions in which they define said external surface, and from which the expander member (23) can be withdrawn to permit said first elements (33) of the tool to be moved inwardly into said cavity prior to their withdrawal, the side faces of at least said portions (34) of the first elements (33), which contact at least said portions (38) of the second elements (37), being parallel to one another or convergent towards the outside of the tool.

3. A tool according to Claim 2 further characterised in that said second elements (37) are supported in use by said side faces of the first elements (33), rather than by said expander member (23).

4. A tool according to Claim 2 or Claim 3 further characterised in that each of said portions (34) of said first elements (33) has a formation (34a) adapted to form one of said grooves of one set thereof, and each of said
5 portions (38) of said second elements (37) has a formation (38a) adapted to form one of said grooves of another set thereof which differs (as herein defined) from said one set.

5. A tool according to Claim 2, Claim 3 or Claim 4 further characterised in that the expander member (23) has a tapered
10 portion which enters said internal cavity (40) defined by said elements (33, 34, 37, 38) of the tool, to facilitate withdrawal of the expander member after a forming operation.

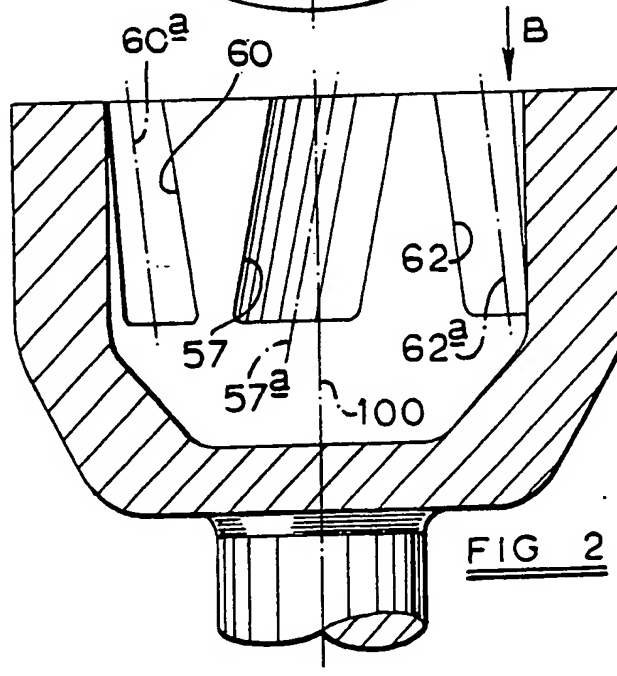
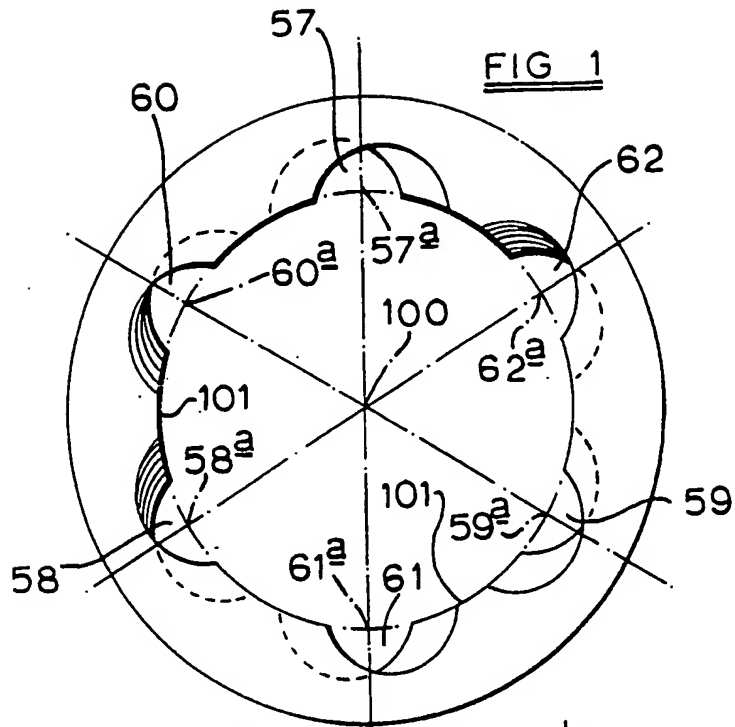
6. A tool according to any one of Claims 2 to 5 further characterised by a holder member (24) which holds said first
15 elements (33) to allow for said inward movement thereof, said holder member (24) being mounted for movement relative to said expander member (23), abutment means (25, 26) engaging said holder member (24) when said expander member (23) is withdrawn from said cavity (40), to withdraw said
20 first elements (33) from said article, and further abutment means (35, 36) engaging said second elements (37) after further withdrawal of said expander member (23) to withdraw said second elements (37) from said article.

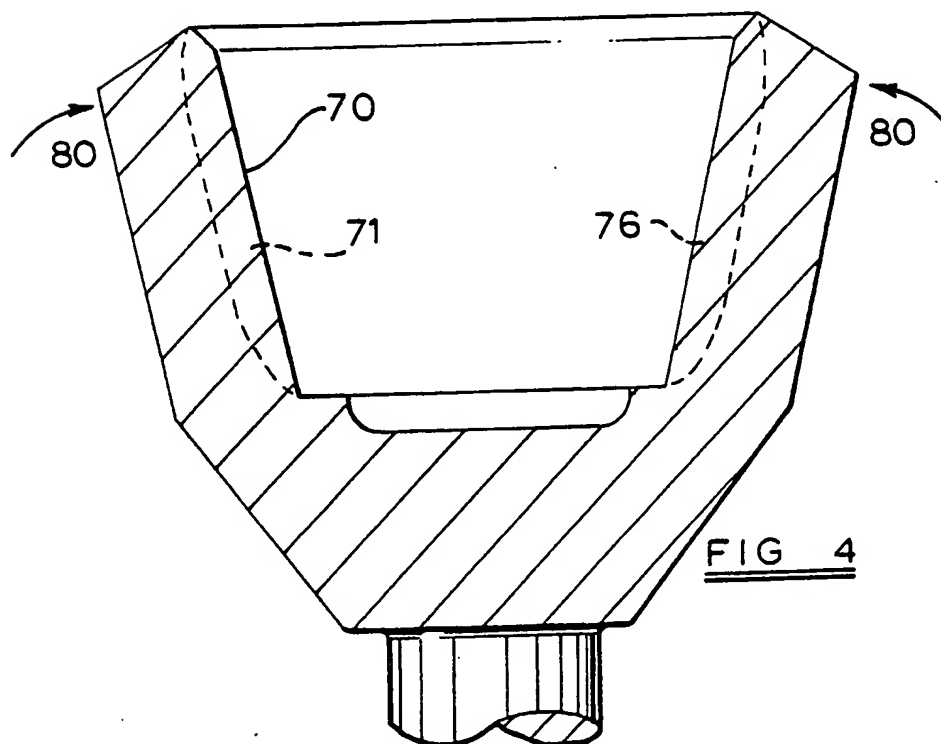
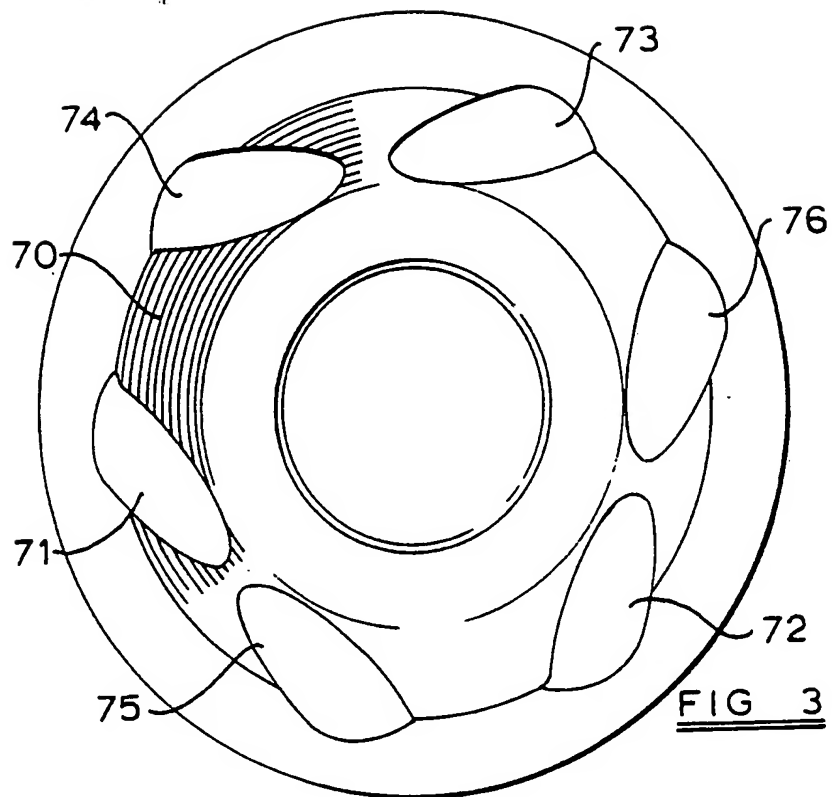
7. A tool according to Claim 6, further characterised by
25 spring means (29) operative between said expander member (23) and said first and second elements (33, 37) to return said elements to their operative positions and said expander member to said cavity.

8. A press fitted with a tool according to any one of the preceding Claims and further characterised by a die (41) through which a hollow blank having the tool inside it can be pressed to form the article, and means for holding said
5 article during withdrawal of the tool therefrom.

9. A method of manufacturing a hollow article using a tool according to any one of Claims 1 to 7, comprising introducing the tool into a hollow blank, subjecting the blank to a forming operation to cause its internal surface
10 to conform to the external surface of the tool, withdrawing said first elements of the tool from the formed blank, and subsequently withdrawing said second elements of the tool therefrom.

10. A tool, or a method of use thereof to manufacture a
15 universal joint outer member, substantially as hereinbefore described with reference to the accompanying drawings.





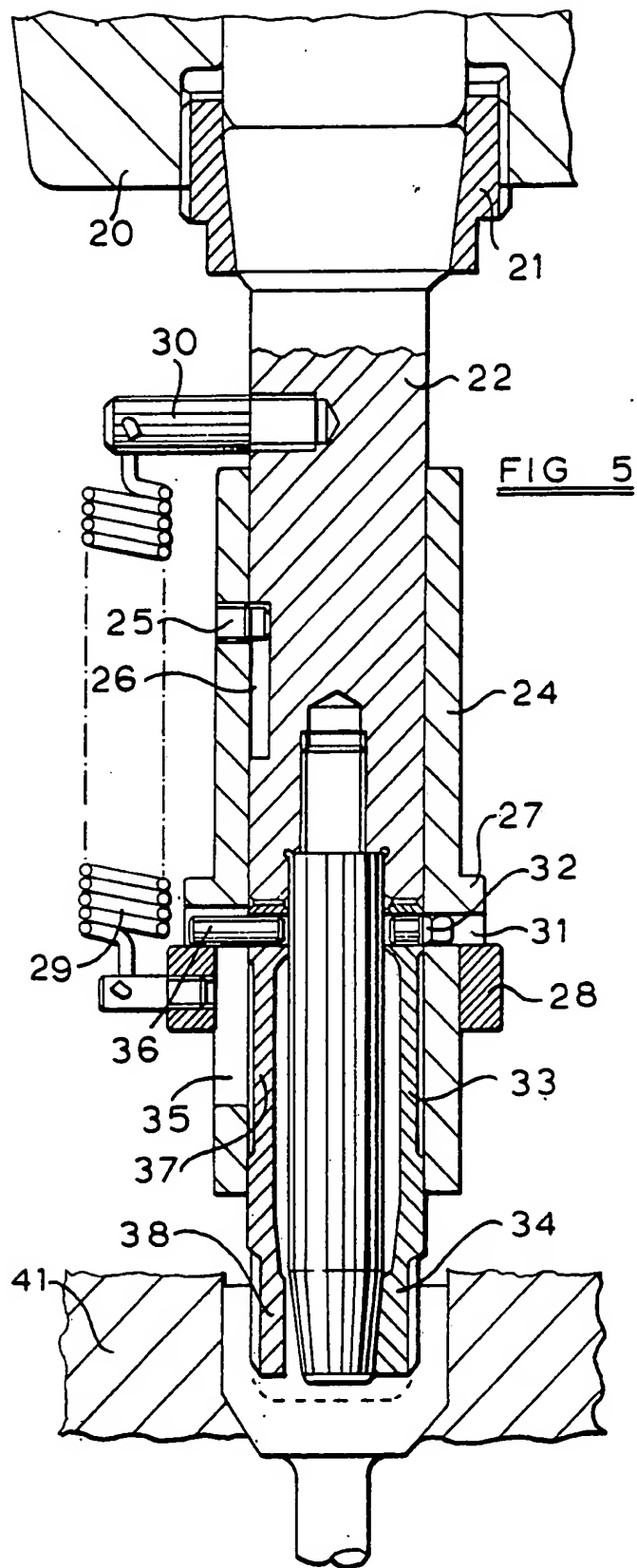
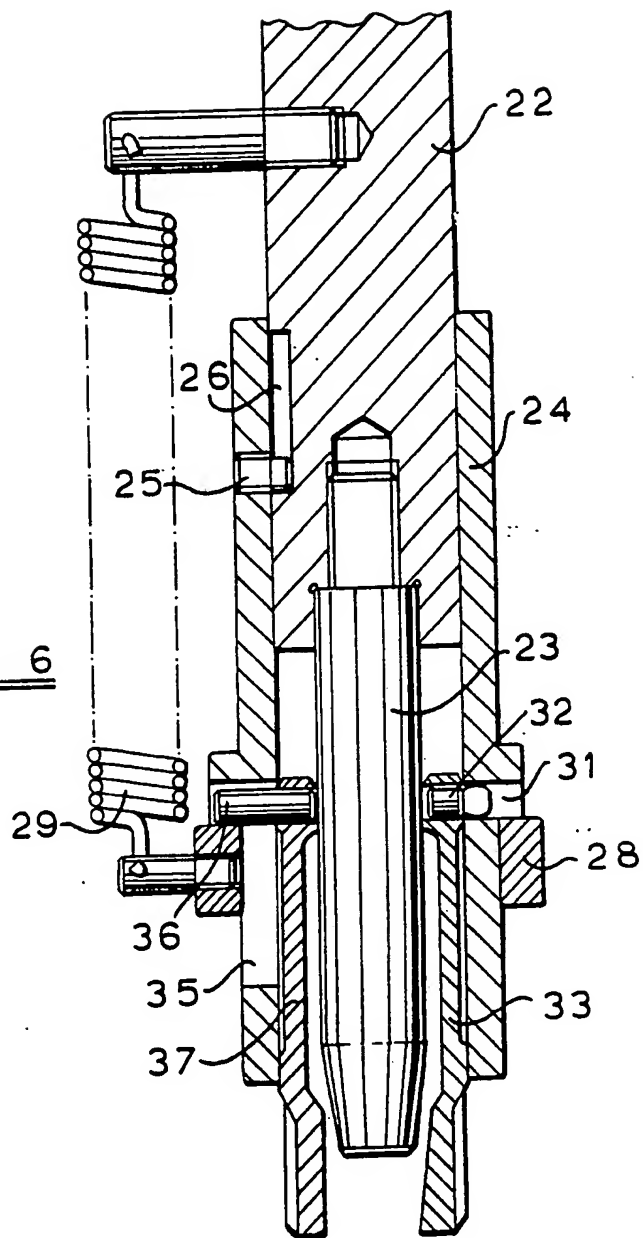
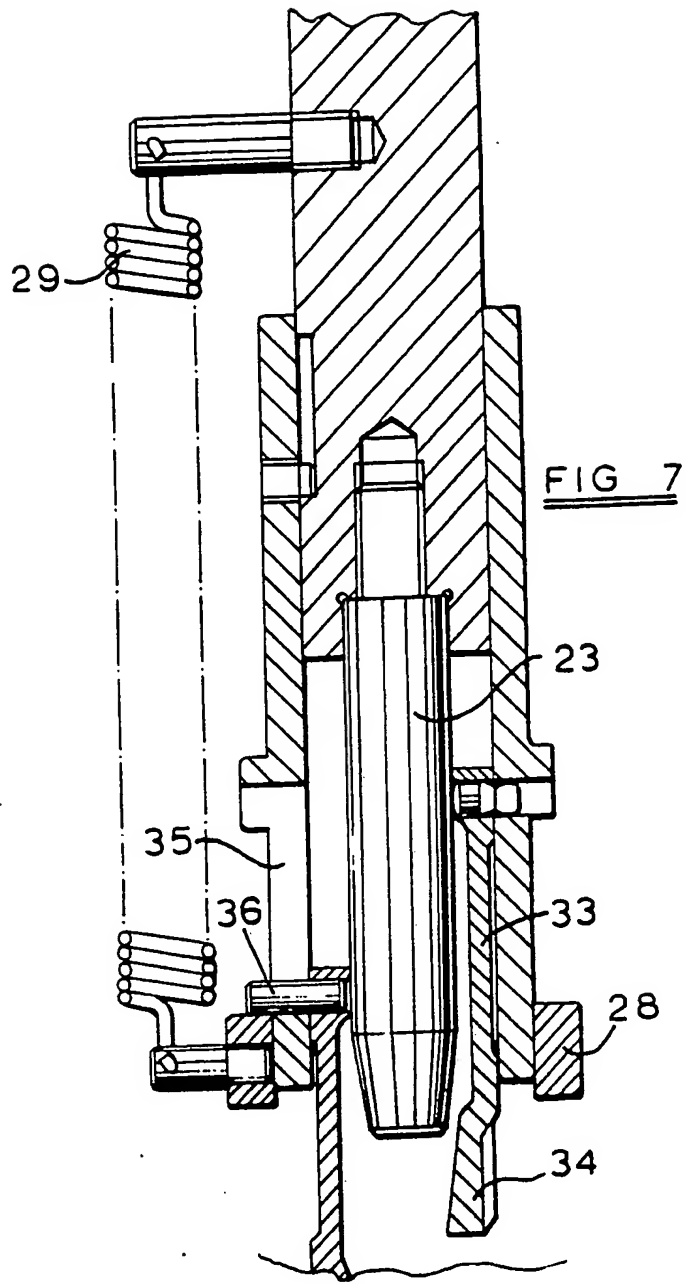
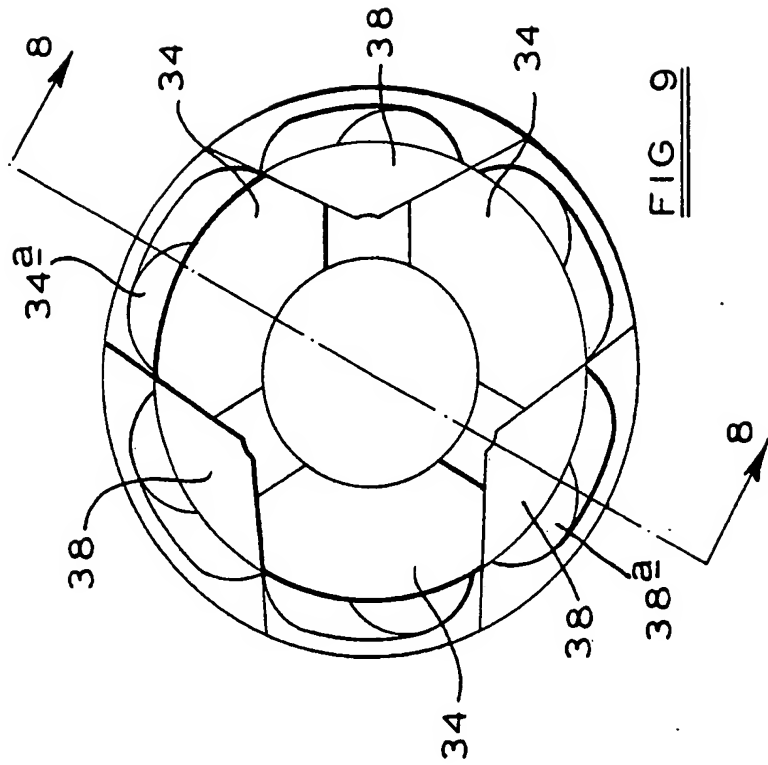
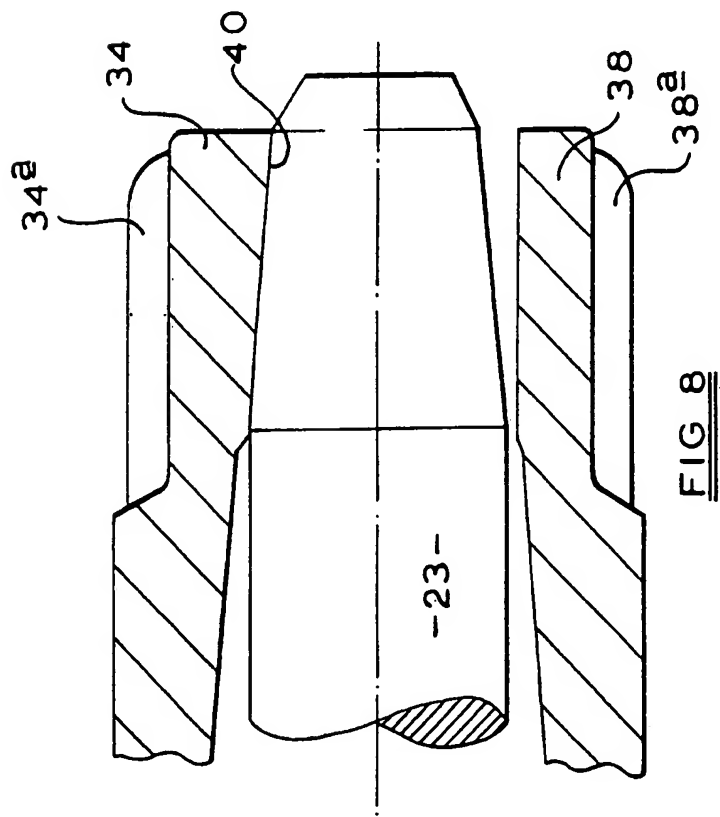


FIG 6







INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 85/00036

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC ⁴ : B 21 K 1/76; B 21 D 53/84																				
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched ⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border-bottom: 1px solid black;">Classification System</th> <th style="border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="padding: 5px;">IPC⁴</td> <td style="padding: 5px;">B 21 K 1/00; B 21 D 39/00; B 21 D 53/00</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸</div>			Classification System	Classification Symbols	IPC ⁴	B 21 K 1/00; B 21 D 39/00; B 21 D 53/00														
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III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; border-bottom: 1px solid black;">Category ⁹</th> <th style="border-bottom: 1px solid black;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="border-bottom: 1px solid black;">Relevant to Claim No. ¹³</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">EP, A1, 0013545 (VEW) 23 July 1980 see claims 1-3; figure 1 ---</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1, 2, 5</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">FR, A, 2474909 (LIEBERGELD) 7 August 1981 see claim 1; figure 7 ---</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1, 2, 5</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">EP, A1, 0023581 (CATERPILLAR) 11 February 1981 see claim 1; figure 1 ---</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">EP, A1, 0094875 (LUCHAIRE) 23 November 1983 see figure 3; claim 1 ---</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1, 2, 5</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">DE, B, 2830275 (VW) 24 January 1980 see claim 1; figure 1 -----</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1, 2, 5</td> </tr> </tbody> </table>			Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	EP, A1, 0013545 (VEW) 23 July 1980 see claims 1-3; figure 1 ---	1, 2, 5	X	FR, A, 2474909 (LIEBERGELD) 7 August 1981 see claim 1; figure 7 ---	1, 2, 5	A	EP, A1, 0023581 (CATERPILLAR) 11 February 1981 see claim 1; figure 1 ---	1	A	EP, A1, 0094875 (LUCHAIRE) 23 November 1983 see figure 3; claim 1 ---	1, 2, 5	A	DE, B, 2830275 (VW) 24 January 1980 see claim 1; figure 1 -----	1, 2, 5
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p> </div> </div>																				
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">Date of the Actual Completion of the International Search <div style="text-align: center;">2nd May 1985</div></td> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">Date of Mailing of this International Search Report <div style="text-align: center;">13 JUIN 1985</div></td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 5px;">International Searching Authority <div style="text-align: center;">EUROPEAN PATENT OFFICE</div></td> <td style="border-bottom: 1px solid black; padding: 5px;">Signature of Authorized Officer <div style="text-align: right;"> G.L.M. Kroymdenberg </div></td> </tr> </table>			Date of the Actual Completion of the International Search <div style="text-align: center;">2nd May 1985</div>	Date of Mailing of this International Search Report <div style="text-align: center;">13 JUIN 1985</div>	International Searching Authority <div style="text-align: center;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer <div style="text-align: right;"> G.L.M. Kroymdenberg </div>														
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This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 06/06/85

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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